Rec'd PCT/PTO 01 JUL 2005

(12) UK Patent Application (19) GB (11) 2 370 671 (13) A

(43) Date of A Publication 03.07.2002

(21) Application No 0122141.5

(22) Date of Filing 13.09.2001

(30) Priority Data
(31) 09694911 (32) 24.10.2000 (33) US

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(51) INT CL^7
B60R 21/01 // G01P 15/00

(52) UK CL (Edition T)
G4N NHVSC N5C2

(56) Documents Cited
EP 0775613 A **EP 0531989 A**
WO 00/40438 A **DE 004220270 A**
US 5916289 A **US 5793005 A**

(58) Field of Search
UK CL (Edition T) **G4N NHVSC**
INT CL^7 **B60R 21/00 21/01 21/16 , G01P 15/00**
Online: EPODOC, JAPIO, WPI

(54) Abstract Title
Side impact sensing system which triggers an inflatable restraint

(57) A side impact sensing system 10 has at least one first sensor 18, 20, 22, 24 mounted on doors 36, 38, 40, 42 of a vehicle 12. At least one second sensor 26 is mounted in the passenger compartment 52. The first and second sensors may be accelerometers and the second sensor may be a structural deformation sensor. The signals from the first and second sensors may be a lateral acceleration of the vehicle. The signals from the first and second sensors are compared to their respective dynamic threshold by controller 14. Controller 14 determines whether to inflate an air-bag 28, 30, 32, 34 based upon the signals from the first and second detectors.

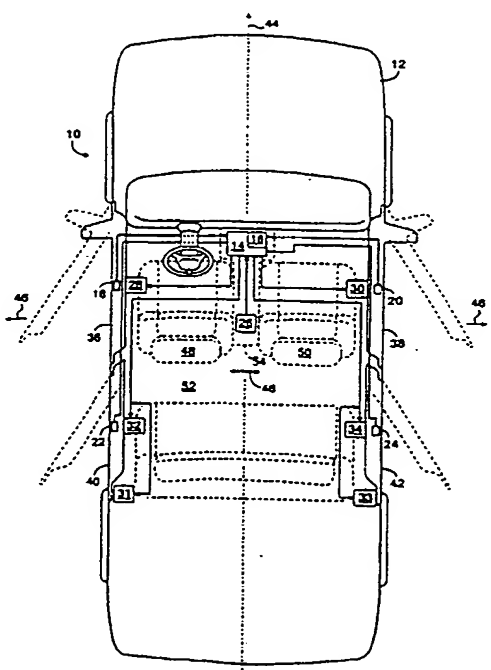

Fig. 1

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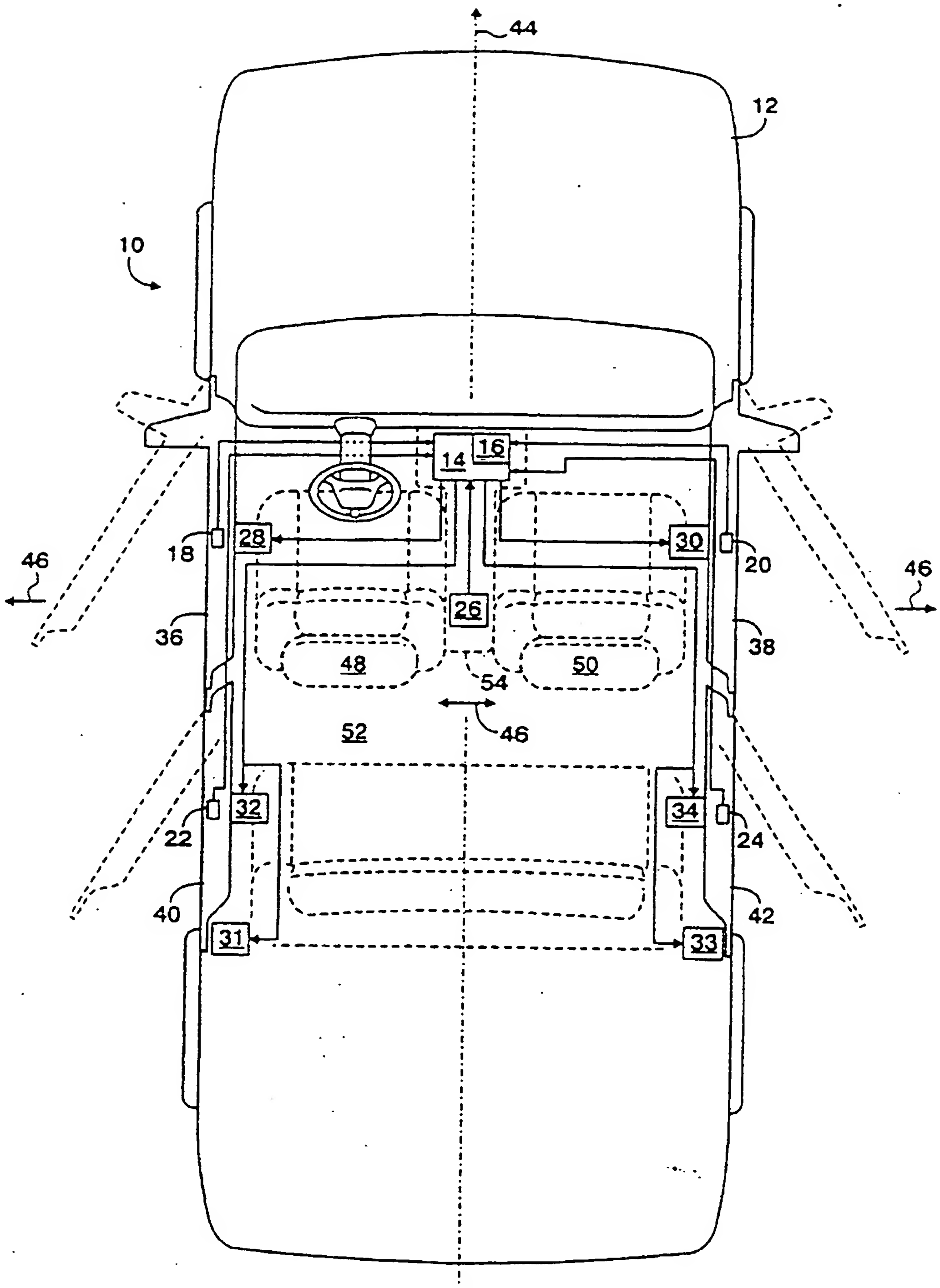
44
12
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14
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18
28
30
20
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22
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42
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33

Fig. 1

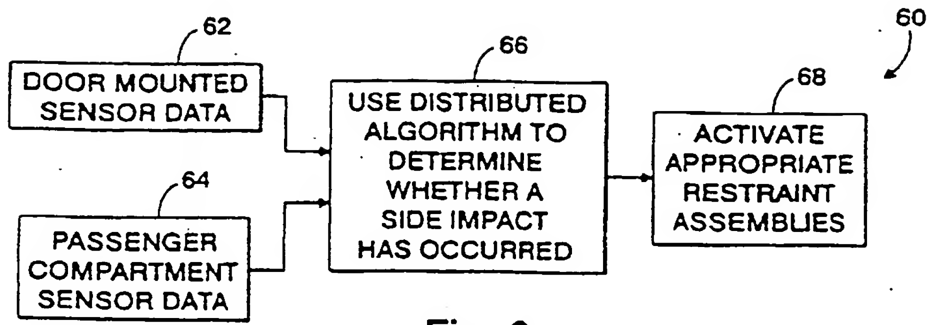
62
DOOR MOUNTED SENSOR DATA
64
PASSENGER COMPARTMENT SENSOR DATA
66
USE DISTRIBUTED ALGORITHM TO DETERMINE WHETHER A SIDE IMPACT HAS OCCURRED
68
ACTIVATE APPROPRIATE RESTRAINT ASSEMBLIES
60

Fig. 2

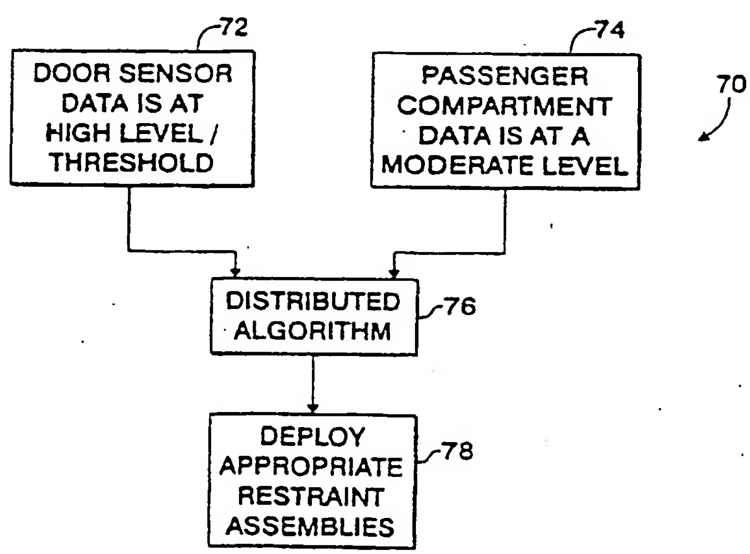
72
DOOR SENSOR DATA IS AT HIGH LEVEL / THRESHOLD
74
PASSENGER COMPARTMENT DATA IS AT A MODERATE LEVEL
70
DISTRIBUTED ALGORITHM
76
DEPLOY APPROPRIATE RESTRAINT ASSEMBLIES
78

Fig. 3

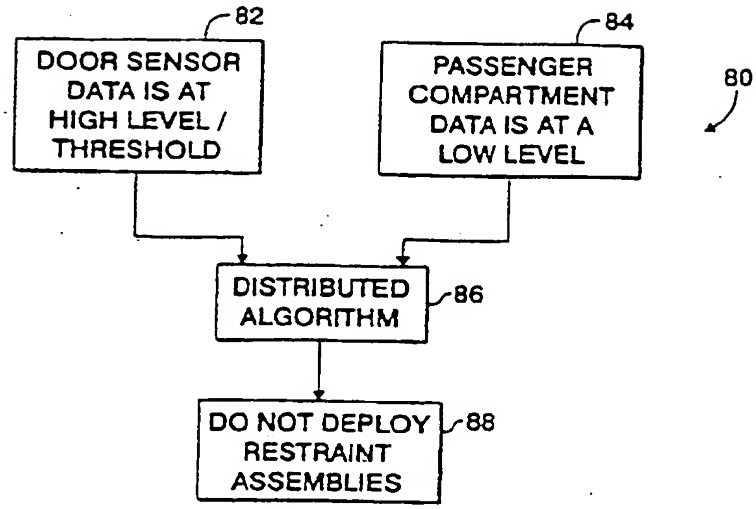
82
DOOR SENSOR DATA IS AT HIGH LEVEL / THRESHOLD
84
PASSENGER COMPARTMENT DATA IS AT A LOW LEVEL
80
DISTRIBUTED ALGORITHM
86
DO NOT DEPLOY RESTRAINT ASSEMBLIES
88

Fig. 4

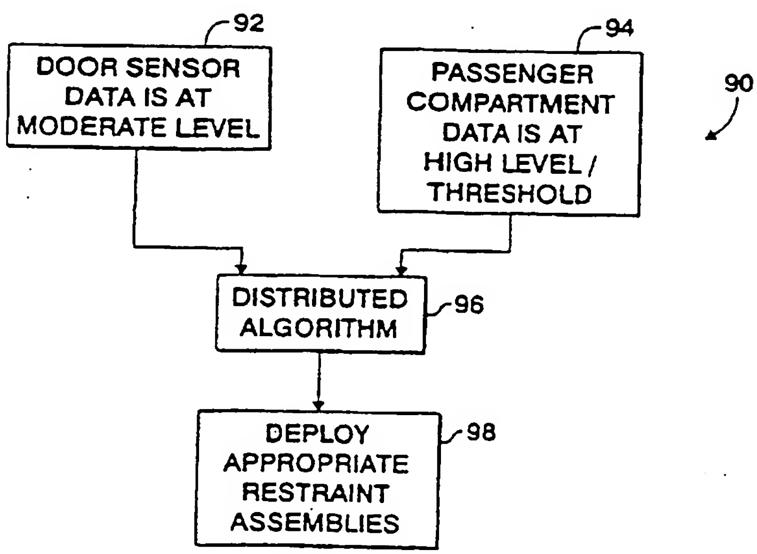
92
DOOR SENSOR DATA IS AT MODERATE LEVEL
94
PASSENGER COMPARTMENT DATA IS AT HIGH LEVEL / THRESHOLD
90
DISTRIBUTED ALGORITHM
96
DEPLOY APPROPRIATE RESTRAINT ASSEMBLIES
98

Fig. 5

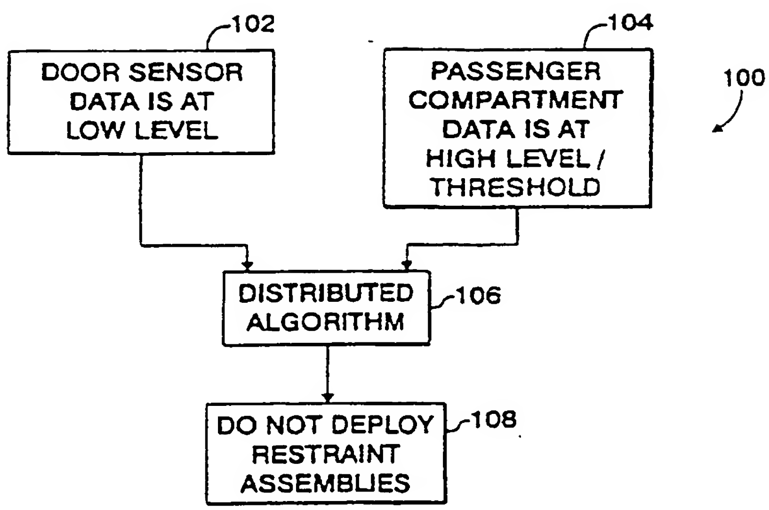
102
DOOR SENSOR DATA IS AT LOW LEVEL
104
PASSENGER COMPARTMENT DATA IS AT HIGH LEVEL / THRESHOLD
100
DISTRIBUTED ALGORITHM
106
DO NOT DEPLOY RESTRAINT ASSEMBLIES
108

Fig. 6

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A SYSTEM FOR SENSING A SIDE IMPACT COLLISION

This invention relates to a system for sensing a side impact collision and, more particularly, to a system which reliably determines when a side impact collision has occurred and which activates one or more vehicle safety devices in response to such a determination.

Safety devices, such as front and side inflatable restraint assemblies or "air bags", are used to reduce the likelihood of injury to occupants of the vehicle in the event of a vehicle collision.

In order to properly protect the occupants of the vehicle, it is desirable to accurately detect a collision so that these safety devices can be engaged or deployed in an appropriate and timely manner.

For example inflatable restraint assemblies, commonly referred to as "air bags" or "curtains", are typically deployed within a vehicle and selectively and inflatably expand into the passenger compartment when the vehicle is struck by or collides with another vehicle or object. One type of inflatable restraint assembly, commonly referred to as a "side air bag", is contained within the seats, doors or sides of the vehicle and is designed to deploy in the event of a relatively severe side impact or collision.

These expandable assemblies substantially protect the vehicle occupants from injury by substantially preventing the occupants from impacting or "crashing into" the side and/or various other portions of the vehicle.

Efforts have been made to detect or sense when a side impact or collision has occurred, and to activate the appropriate safety devices (e.g., the side air bags) upon such detection so far these efforts have not produced a

sensitive system that can distinguish accurately between a minor impact and a major one.

It is an object of this invention to provide an improved system for detecting side impacts.

According to a first aspect of the invention there is provided a system for detecting a side impact collision to a vehicle having at least one door and a passenger compartment and for activating a safety device in response to said detection, the system comprising a selectively operable safety device, a first sensor mounted on the or each door and arranged to generate a first signal representing a first impact data value, at least one second sensor mounted within the passenger compartment arranged to generate a second signal representing a second impact data value, a controller communicatively coupled to the selectively operable safety device, to each first sensor and to each second sensor and being arranged to receive said first and second signals and selectively send a signal to the selectively operable safety device wherein the controller is arranged to compare the first and second signals in order to determine whether a side impact collision has occurred and to selectively activate said safety device in response to said determination.

The vehicle may have a plurality of side doors and there is a first sensor mounted on each of said of doors wherein each of the first sensors is arranged to measure impact data and to generate a plurality of first signals in response to said measured impact data, the controller being arranged to receive said plurality of first signals and said second signal, and based upon said plurality of first signals and said second signal, to determine whether a side impact collision has occurred.

The controller may determine whether a side impact collision has occurred by comparing the or each first signal to a first threshold value and by comparing the or each second signal to a second threshold value.

The first and second threshold values may be dynamic threshold values.

The first impact data value may be a first lateral acceleration value.

The second impact data value may be a second lateral acceleration value.

The vehicle passenger compartment may have a centre portion and at least one second sensor may be disposed in relative close proximity to said centre portion.

The centre portion may be a tunnel portion.

The or each first sensor may be an accelerometer or may be a structural deformation sensor.

The or each second sensor may be an accelerometer.

The safety device may comprise at least one side impact air bag.

There may be several selectively inflatable side air bag assemblies and said controller is arranged to selectively inflate at least one of said plurality of selectively inflatable side air bag assemblies when a side impact collision is detected.

According to a second aspect of the invention there is provided a method for sensing a side impact collision to a vehicle having a plurality of doors, a passenger compartment

and at least one inflatable restraint assembly, each door having a first sensor mounted thereon and there being at least one second sensor disposed within said passenger compartment wherein the method comprises the steps of monitoring the or each first sensor and the or each second sensor to determine whether a side collision is occurring, and selectively activating the or each inflatable restraint assembly in response to said determination.

The invention will now be described by way of example with reference to the accompanying drawing of which:-

Figure 1 is a block diagram of a system for sensing a side impact collision which incorporates the teachings of the preferred embodiment of the invention and which is deployed on a vehicle.

Figure 2 is a block diagram illustrating the general functionality of the system shown in Figure 1.

Figure 3 is a block diagram illustrating a first type of deployment decision made by the system shown in Figure 1.

Figure 4 is a block diagram illustrating a first type of non-deployment decision made by the system shown in Figure 1.

Figure 5 is a block diagram illustrating a second type of deployment decision made by the system shown in Figure 1.

Figure 6 is a block diagram illustrating a second type of non-deployment decision made by the system shown in Figure 1.

Referring now to Figure 1, there is shown a side impact collision sensing system 10 which is deployed on a vehicle 12. The system 10 includes a conventional microprocessor,

microcontroller or controller 14 having a memory unit 16 and operating under stored program control.

Controller 14 is electrically and communicatively coupled to impact sensors 18, 20, 22, and 24 which are respectively mounted to the doors 36, 38, 40 and 42 of vehicle 12. Controller 14 is further electrically and communicatively coupled to a sensor 26 which is disposed within the passenger compartment 52 of vehicle 12, and to vehicle occupant safety devices or assemblies 28, 30, 31, 32, 33 and 34. As described more fully and completely below, controller 14 receives signals generated by sensors 18 - 26, processes and utilizes the received signals to determine whether a side impact collision to the vehicle 12 is occurring or has occurred, and selectively activates safety devices 28 - 34, if such a determination is made, thereby protecting the vehicle's occupants from harm and/or injury.

The controller 14 is mounted within or in relative close proximity to the "tunnel" portion 54 of the passenger compartment 52 (e.g., between front seats 48, 50). The controller 14 is a conventional controller and may include one or more microprocessors and/or integrated circuits which control the operation of system 10. The memory unit 16 is a conventional memory unit including both permanent and temporary memory, and is adapted to and does store at least a portion of the operating software and/or crash detection algorithms which direct the operation of controller 14.

The Memory 16 is also adapted to selectively store other types of data or information, including information associated with the operation of the system, historical data, processing data, and/or operational data. As should also be apparent to those of ordinary skill in the art, controller 14 and memory 16 may actually comprise a plurality of commercially available, conventional, and

disparate chips or devices which are operatively and communicatively linked in a cooperative manner.

Each of sensors 18 - 24 comprises a conventional and commercially available door-mounted impact sensor (e.g., an accelerometer or other door mounted sensing device such as a structural or crush type sensor) which measures certain information pertaining to the acceleration of the respective door 36 - 42 on which the sensor is mounted.

Each sensor 18 - 24 is respectively mounted in relative close proximity to the "centre" or the "rear" of each door 36 - 42. The sensors 18 - 24 measure the "lateral" acceleration of each of the respective doors 36 - 42 (i.e., the acceleration along the "Y-axis" or in the directions of arrows 46 which are substantially perpendicular to the longitudinal axis 44 of vehicle 12) or the amount or rate of crush.

Sensors 18 - 24 provide data representing the measured values to controller 14, which utilizes these values to determine the "lateral" or "Y-axis" acceleration of each of the doors 36 - 42. As described more fully and completely below, controller 14 utilizes these values along with data from sensor 26 in a "distributed" crash prediction algorithm to determine whether the measured "lateral" or "Y-axis" acceleration or "severity" is consistent with a side impact collision occurring at one or more of the doors 36 - 42 and determines whether the inflation of any of devices 28 -34 is required.

Each sensor 18 - 24 includes a self-contained controller which analyzes the measured acceleration of each of the respective doors 36 - 42, which determines whether the measured "lateral" or "Y-axis" acceleration or "severity" is consistent with a "door" collision (e.g., a collision which impacts or crushes one or more of the

vehicle's doors 36 - 42), and which communicates a signal to controller 14 if a "door" collision is detected.

The controller 14 analyzes the generated signal along with data from sensor 26 to determine whether the deployment of any of air bags 28 - 34 is required.

Alternate sensors comprise other types of impact sensors, such as mechanical switch-type sensors or structural deformation or stress sensors, which are adapted to detect the structural deformation and/or stress accompanying a side impact collision. These sensors may include filtering and/or processing devices or circuits which filter and/or process their respective measured data prior to sending the data to controller 14.

The sensor 26 is mounted in relative close proximity to the centre of the passenger compartment 52 (e.g., within the "tunnel" portion 54 between seats 48 and 50 and/or within controller 14) and comprises a conventional and commercially available accelerometer. Sensor 26 measures the "lateral" acceleration (i.e., acceleration along the "Y-axis" or in the directions 46 which are substantially perpendicular to the longitudinal axis 44 of vehicle 12) of the vehicle 12. Sensor 26 provides data representing the measured acceleration values to controller 14, which utilizes these values to determine the "lateral" or "Y-axis" acceleration of the vehicle 12.

The sensor 26 includes a self-contained controller which analyzes the measured acceleration, and which determines whether the measured "lateral" or "Y-axis" acceleration is consistent with a "deployment" type side collision (e.g., a side collision which is severe enough to warrant the deployment of one or more air bags 28 - 34) or a "non-deployment" type side collision (e.g., a side collision which is not severe enough to warrant the deployment of one

or more air bags 28 - 34), and which communicates a signal to controller 14. The sensor 26 may also include filtering and/or processing devices or circuits which filter and/or process the measured data prior to sending the data to controller 14.

Safety devices or restraint assemblies 28 - 34 each comprise one or more conventional and commercially available side impact inflatable restraint assemblies or side impact "air bags", and are disposed within and/or around the passenger compartment 52 of vehicle 12. Assemblies 28 - 34 may further include one or more conventional seat belt pre-tensioning assemblies. Assemblies 28 - 34 are selectively activated in response to the receipt of one or more command or control signals from controller 14.

The operative functionality of the system is achieved by the use of certain software and/or firmware operatively stored within system 10 and more particularly within memory unit 16 and/or within controller 14. To understand the general operation of system 10, reference is now made to flow chart or diagram 60 of Figure 2, illustrating the broad functionality of system 10.

Data 62 represents data received from door-mounted sensors 18 - 24. Data 62 contains information relating to the measured acceleration or structural deformation of each the vehicle's doors 36 - 42, which may be indicative of or correspond to a side impact collision. Controller 14 monitors and/or receives data 62, and processes data 62 to determine whether a "door collision" (i.e., a collision which crushes/impacts one or more of doors 36 - 42) has occurred or is occurring. Particularly, controller uses this data 62 in conjunction with data 64 from sensor 26 to determine whether an object has struck or impacted any of the doors 36 - 42 of vehicle 12, and if so, whether the

collision is severe enough to warrant a deploying or activating any one or more of restraint assemblies 28 - 34.

Data 64 represents the lateral or "Y-axis" acceleration of the vehicle 12, measured at a location in general proximity to the centre of the passenger compartment 52 by sensor 26. Controller 14 monitors and/or receives data 64, and processes data 64 to determine whether a collision has occurred or is occurring. Particularly, using conventional algorithms, controller 14 determines whether an object, such as another vehicle, has struck or impacted vehicle 12, and if so, whether the collision is severe enough to warrant a deploying or activating any one or more of restraint assemblies 28 - 34.

As illustrated in block 66 and as discussed more fully and completely below, controller 14 utilizes a "distributed" algorithm (e.g., analyzes both data 62 and data 64) to determine whether a side impact collision has occurred or is occurring and whether the collision is severe enough to warrant or require the activation or deployment of any of restraint assemblies 28 - 34. If controller 14 determines that the activation or deployment of any of restraint assemblies 28 - 34 is necessary, controller 14 communicates a signal to any one or more of the assemblies 28 - 34, thereby activating the assemblies and protecting the occupants of vehicle 12, as shown in block 68. In order to better understand the operation and/or deployment decision-making process of controller 14, reference now made to Figures 3 through 6 which illustrate various deployment and non-deployment decisions made by controller 14.

Referring now to Figure 3, there is shown a flow chart or flow diagram 70 illustrating a deployment decision made by the "distributed" algorithm performed by controller 14. As shown in functional block or step 72, controller 14 receives data from "door-mounted" sensors 18 - 24 (e.g.,

data 62) which corresponds to a high level of acceleration (e.g., acceleration measurements exceeding or approaching a predetermined "high" threshold value) which is indicative or representative of a side impact collision that is localized at one or more of the respective doors 36 - 42. In functional block or step 76, controller 14 analyzes the data 72 in combination with data from sensor 26 (i.e., data 64) in order to more accurately make a deployment/non-deployment decision. As shown in functional block or step 74, in this non-limiting example, the data from sensor 26 corresponds to a moderate level or value of lateral acceleration measured within the passenger compartment 52. In the preferred embodiment of the invention, after receiving a high acceleration value or "deployment" signal from one or more of sensors 18 - 24, controller 14 further ensures that the passenger compartment acceleration data (e.g., data 64) meets a moderate or lower threshold level or value prior to deploying any of restraint assemblies 28-34. In one non-limiting embodiment, this moderate or lower threshold level is a dynamic threshold value (e.g., the threshold value is a function of the acceleration values measured by sensors 18 - 24).

As illustrated by functional block or step 78, the moderate acceleration value measured by sensor 26 and the high acceleration value(s) measured by sensors 18 - 24 results in the deployment of one or more of assemblies 28-34 (e.g., controller 14 communicates a signal to any one or more of the assemblies 28 - 34, thereby activating the assemblies and protecting the occupants of vehicle 12).

Referring now to Figure 4, there is shown a flow chart or flow diagram 80 illustrating a non-deployment decision made by the "distributed" algorithm performed by controller 14. As shown in functional block or step 82, controller 14 receives data from "door-mounted" sensors 18 - 24 (e.g., data 62) which corresponds to a high level of acceleration

(e.g., acceleration measurements exceeding or approaching a predetermined "high" threshold value) which is indicative or representative of a side impact collision that is localized at one or more of the respective doors 36 - 42. In functional block or step 86, controller 14 analyzes the data from sensors 18-24 in combination with data from sensor 26 (i.e., data 64) in order to accurately make a deployment/non-deployment decision.

As shown in functional block or step 84, the data from sensor 26 corresponds to a low level or value of lateral acceleration measured within the passenger compartment 52. In this non-limiting example, the data from sensor 26 (e.g., data 64) does not meet the moderate or lower threshold level which is required for a deployment decision. Hence, the relatively low acceleration value measured by sensor 26 and the high acceleration value(s) measured by sensors 18 - 24 results in a non-deployment decision (e.g., controller 14 does not activate any of the assemblies 28 - 34), as illustrated in functional block or step 98.

By requiring data 64 to meet a "moderate" threshold or level after data 62 has reached a "high" level or value, system 10 utilities sensor 26 to assist sensors 18 - 24 in discriminating between "deployment" type impacts and "non-deployment" type impacts. Hence, system 10 provides for improved discrimination over prior systems which include only door-mounted sensors, and allows for relatively minor impacts which directly impact the doors of the vehicle to occur without unnecessary activation of the restraint assemblies 28-34.

System 10 therefore allows sensors 18-24 to be "set" or calibrated at a relatively more "sensitive" level, while substantially and desirably reducing the likelihood of an unnecessary deployment or activation of any of the restraint assemblies 28 - 34 relative to prior systems.

Referring now to Figure 5, there is shown a flow chart or flow diagram 90 illustrating a deployment decision made by the "distributed" algorithm performed by controller 14. As shown in functional block or step 94, controller 14 receives data from sensor 26 (i.e., data 64) which corresponds to a high level of acceleration (e.g., an acceleration measurement exceeding or approaching a predetermined threshold value) in the passenger compartment of the vehicle and which is indicative or representative of a side impact collision. In functional block or step 96, controller 14 analyzes the data 64 in combination with data from "door-mounted" sensors 18 - 24 (e.g., data 62) in order to more accurately make a deployment/non-deployment decision.

As shown in functional block or step 92 the data from sensors 18 - 24 corresponds to a moderate level or value of lateral acceleration measured within the passenger compartment 52. After receiving the high acceleration value or "deployment" signal from sensor 26, controller 14 further ensures that the door-mounted sensor data (e.g., data 64) meets a moderate or lower threshold level or value prior to deploying any of restraint assemblies 28-34.

The value of this moderate or lower threshold level is a "dynamic" threshold value (e.g., the threshold value is a function of the acceleration values measured by sensor 26).

As illustrated by functional block or step 98, the moderate acceleration measured by sensors 18 - 24 and the high acceleration value measured by sensors 26 results in the deployment of one or more of assemblies 28-34 (e.g., controller 14 communicates a signal to any one or more of the assemblies 28 - 34, thereby activating the assemblies and protecting the occupants of vehicle 12).

Referring now to Figure 6, there is shown a flow chart or flow diagram 100 illustrating a non-deployment decision made by the "distributed" algorithm performed by controller 14. As shown in functional block or step 104, controller 14 receives data from sensor 26 (e.g., data 64) which corresponds to a high level of acceleration (e.g., an acceleration measurement exceeding or approaching a predetermined threshold value) within the passenger compartment 52 and which is indicative or representative of a side impact collision.

In functional block or step 106, controller 14 analyzes the data 64 in combination with data from sensors 18 - 24 (i.e., data 62) in order to accurately make a deployment or non-deployment decision.

As shown in functional block or step 102 the data from sensors 18 - 24 corresponds to a low level or value of lateral acceleration measured at the doors of vehicle 12. The data from sensors 18 - 24 (e.g., data 62) does not meet the moderate or lower threshold level or value which is required for a deployment decision. Hence, when processed by the controller algorithm, the relatively low acceleration value measured by sensors 18 - 24 and the high acceleration value(s) measured by sensor 26 results in a non-deployment decision (e.g., controller 14 does not activate any of the assemblies 28 - 34).

By requiring data 64 to meet a "moderate" threshold or level after data 62 has reached or exceeded a "high" level or value, system 10 utilizes sensor 18 - 24 to assist sensor 26 in discriminating between "deployment" type impacts and "non-deployment" type impacts.

Hence, system 10 provides for improved discrimination over prior systems which include only a passenger compartment sensor. Furthermore, because system 10 utilizes

sensors 24 - 28 to assist sensor 26 in discriminating between "deployment" and "non-deployment" type collisions, the "sensitivity" of the sensor 26 can be lowered or decreased and/or the threshold value(s) used to determine whether such a "non-door collision" has occurred may be desirably raised. In this manner, sensors 18 - 24 and sensor 26 synergistically and cooperatively reduce the likelihood of false or unnecessary deployment of the vehicle's restraint assemblies, while continuing to achieve timely and proper deployment of the restraint assemblies in a severe collision.

It should be appreciated that in other alternate embodiments additional steps or procedures could be utilised for example, each of the thresholds used by controller 14 to determine whether a side impact collision has occurred could be "dynamic" thresholds, and could be functions based upon one or more vehicle operating conditions and/or other data received from various other vehicle sensors and systems.

CLAIMS

(1) A system for detecting a side impact collision to a vehicle having at least one door and a passenger compartment and for activating a safety device in response to said detection, the system comprising a selectively operable safety device, a first sensor mounted on the or each door and arranged to generate a first signal representing a first impact data value, at least one second sensor mounted within the passenger compartment arranged to generate a second signal representing a second impact data value, a controller communicatively coupled to the selectively operable safety device, to each first sensor and to each second sensor and being arranged to receive said first and second signals and selectively send a signal to the selectively operable safety device wherein the controller is arranged to compare the first and second signals in order to determine whether a side impact collision has occurred and to selectively activate said safety device in response to said determination.

(2) A system as claimed in claim 1 in which the vehicle has a plurality of side doors and there is a first sensor mounted on each of said of doors wherein each of the first sensors is arranged to measure impact data and to generate a plurality of first signals in response to said measured impact data, the controller being arranged to receive said plurality of first signals and said second signal, and based upon said plurality of first signals and said second signal, to determine whether a side impact collision has occurred.

(3) A system as claimed in claim 1 or in claim 2 wherein said controller determines whether a side impact collision has occurred by comparing the or each first signal to a first threshold value and by comparing the or each second signal to a second threshold value.

(4) A system as claimed in claim 3 wherein said first and said second threshold values are dynamic threshold values.

(5) A system as claimed in any of claims 1 to 4 in which the first impact data value is a first lateral acceleration value.

(6) A system as claimed in any of claims 1 to 4 in which the second impact data value is second lateral acceleration value.

(7) A system as claimed in any preceding claim wherein said vehicle passenger compartment has centre portion and at least one second sensor is disposed in relative close proximity to said centre portion.

(8) A system as claimed in claim 7 wherein the centre portion is a tunnel portion.

(9) A system as claimed in any preceding claim wherein the or each first sensor is an accelerometer.

(10) A system as claimed in any preceding claim wherein said the or each second sensor is an accelerometer.

(11) A system as claimed in any of claims 1 to 9 in which the or each first sensor is a structural deformation sensor.

(12) A system as claimed in any preceding claim wherein said safety device comprises at least one side impact air bag.

(13) A system as claimed in claim 11 in which there are several selectively inflatable side air bag assemblies and

said controller is arranged to selectively inflate at least one of said plurality of selectively inflatable side air bag assemblies when a side impact collision is detected.

(15) A method for sensing a side impact collision to a vehicle having a plurality of doors, a passenger compartment and at least one inflatable restraint assembly, each door having a first sensor mounted thereon and there being at least one second sensor disposed within said passenger compartment wherein the method comprises the steps of monitoring the or each first sensor and the or each second sensor to determine whether a side collision is occurring, and selectively activating the or each inflatable restraint assembly in response to said determination.

(16) A method substantially as described herein with reference to the accompanying drawing.

(17) A system for detecting a side impact collision to a vehicle substantially as described herein with reference to the accompanying drawing.

Application No: GB 0122141.5
Claims searched: 1 to 13

Examiner: Mark Gainey
Date of search: 29 April 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): G4N (NHVSC)

Int Cl (Ed.7): B60R(21/00, 21/01, 21/16), G01P(15/00)

Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0775613 A	MORTON INTERNATIONAL INC. see figure 1 and 2	-
A	EP 0531989 A	TOYOTA, NIPPONDENSO & NIPPON SOKEN INC. see figure 1, 4 & col. 6 l. 45 - col. 7 l. 30	-
A	WO 00/40438	SIEMENS AUTOMOTIVE CORPORATION see figure 1 p.4 ll.1 - 16, p. 5 ll. 9- 11	-
A	DE 4220270 A	BOSCH GmbH see figure 1,3 & col. 1 ll.47 - 65	-
A	US 5916289	FAYYAD et al. see figure 1	-
A	US 5793005	KATO see figure 5, col. 1 ll.41 -59 and col.2 ll.1 - 9	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.